PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : H05K 13/02, 13/00

A1

(11) International Publication Number: WO 87/04043

(43) International Publication Date: 2 July 1987 (02.07.87)

(21) International Application Number: PCT/US85/02575

(22) International Filing Date: 23 December 1985 (23.12.85)

(71) Applicant: ASYST TECHNOLOGIES [US/US]; 46309 Warm Springs Boulevard, Fremont, CA 94539 (US).

(72) Inventors: MANEY, George, Allan ; 1450 Oak Creek Drive #104, Palo Alto, CA 94304 (US). FARACO, W., George ; 13561 Howen Drive, Saratoga, CA 95070 (US). PARIKH, Mihir ; 7174 Wooded Lake Drive, San Jose, CA 95120 (US).

(74) Agent: LOVEJOY, David, E.; Fliesler, Dubb, Meyer & Lovejoy, Four Embarcadero Center, Suite 1740, San Francisco, CA 94111-4156 (US).

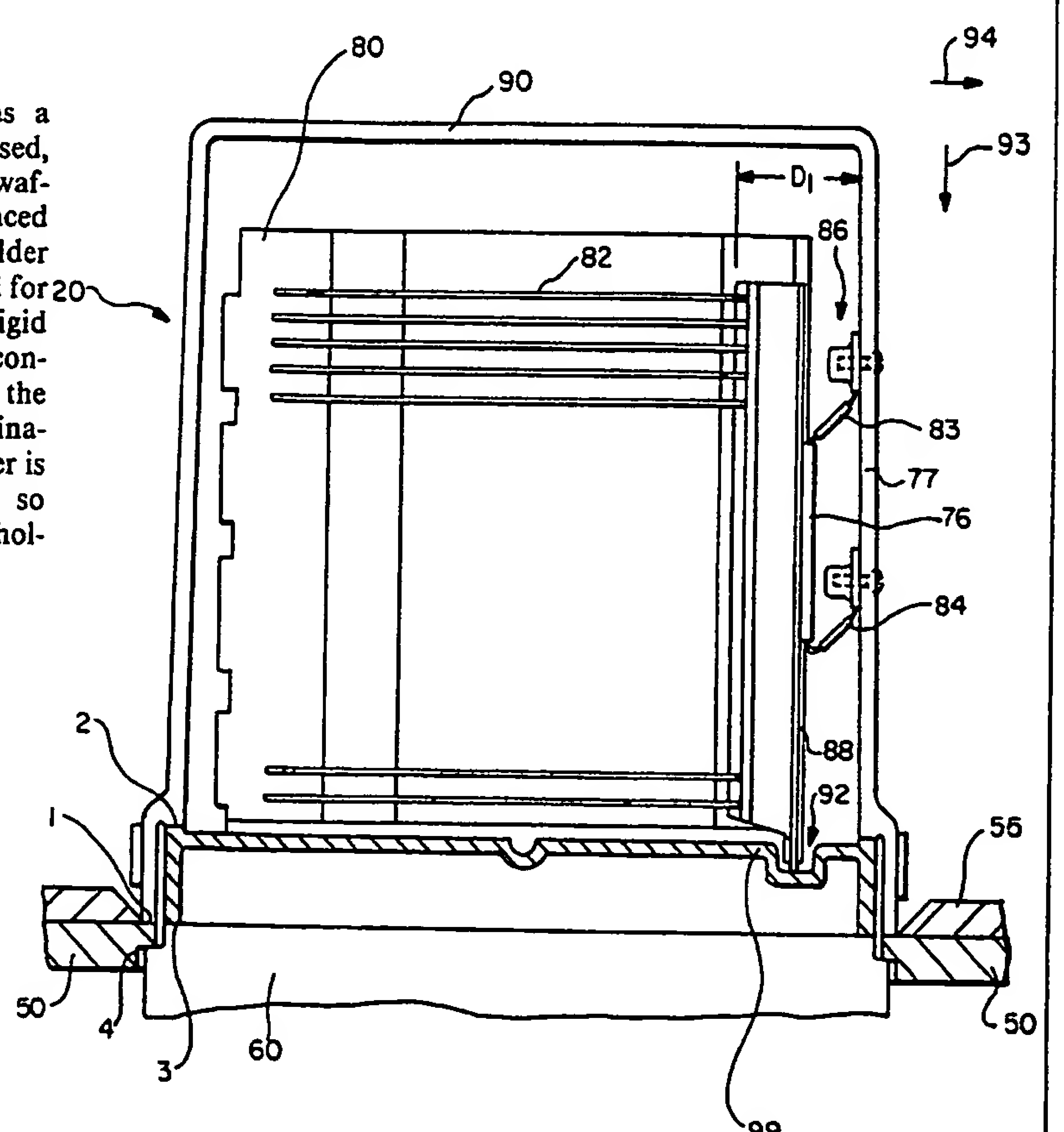
(81) Designated States: DE (European patent), GB (European patent), JP, KR, NL (European patent).

Published
With international search report.

(54) Title: BOX DOOR ACTUATED RETAINER

(57) Abstract

A transportable container, such as a box, for maintaining articles to be processed, such as semiconductor wafers, clean. The wafers or other articles to be processed are placed in a holder. A rigid base supports the holder within the container. A retainer is provided for retaining the articles in the holder. The rigid base and holder are retractable from the container into a clean environment whereby the articles can be processed without contamination. When the base is retracted, the retainer is automatically retracted from the articles so that the articles can be removed from the holder.



BOX DOOR ACTUATED RETAINER

BACKGROUND OF THE INVENTION

The present invention relates to standardized mechanical interface systems for reducing particle contamination and more particularly to apparatus employing sealed containers suitable for use in semiconductor processing equipment to prevent particle contamination.

A standardized mechanical interface (SMIF) has been proposed to reduce particle contamination by significantly reducing particle fluxes onto wafers. This end is accomplished by mechanically ensuring that during transport, storage and processing of the wafers, the gaseous media (such as air or nitrogen) surrounding the wafers is essentially stationary relative to the wafers and by ensuring that particles from the ambient outside environment do not enter the immediate internal wafer environment.

Control of particulate contamination is imperative for cost effective, high-yielding and profitable manufacturing of VLSI circuits. Because design rules increasingly call for smaller and smaller lines and spaces, it is necessary to exert greater and greater control on the number of particles and to remove particles with smaller and smaller diameters.

Some contamination particles cause incomplete etching in spaces between lines, thus leading to an unwanted electrical bridge. In addition to such physical defects, other contamination particles may cause electrical failure due to induced ionization or trapping centers in gate dielectrics or junctions.

The main sources of particulate contamination are personnel, equipment, and chemicals. Particles given off by personnel are transmitted through the environment and through physical contact or migration onto the wafer surface. People, by shedding of skin flakes, for example, are a significant source of particles that are easily ionized and cause defects. Although clean room garments reduce particle emissions they do not fully contain the emissions. It has been found that as many as 6000 particles per minute are emitted into an adjacent one cubic foot of space by a fully suited operator.

To control contamination particles, the trend in the industry is to build more elaborate (and expensive) clean rooms with HEPA and ULPA recirculating air systems. Filter efficiencies of 99.999% and up to ten complete air exchanges per minute are required to obtain an acceptable level of cleanliness.

Particles within the equipment and chemicals are termed "process defects." To minimize process defects, processing equipment manufacturers must prevent machine generated particles from reaching the wafers, and suppliers of gases and liquid chemicals must deliver cleaner products. Most important, a system must be designed that will effectively isolate wafers from particles during storage, transport and transfer into processing equipment. The Standard Mechanical Interface (SMIF) system has been proposed to achieve this goal.

The SMIF concept is based on the realization that a small

volume of still, particle-free air, with no internal source of particles, is the cleanest possible environment for wafers. Further details of one proposed system are described in the article "SMIF: A TECHNOLOGY FOR WAFER CASSETTE TRANSFER IN VLSI MANUFACTURING", by Mihir Parikh and Ulrich Kaempf, Solid State Technology, July 1984, pp. 111-115 and in the above cross-referenced application.

The proposed SMIF system has three main components, namely, (1) minimum volume, dustproof boxes are used for storing and transporting wafer cassettes; (2) canopies are placed over cassette ports of processing equipment so that the environments inside the boxes and canopies become miniature clean spaces; (3) doors on the boxes are designed to mate with doors on the interface ports on the equipment canopies and the two doors are opened simultaneously so that particles which may have been on the external door surfaces are trapped ("sandwiched") between the doors.

In the proposed SMIF system, a box is placed at the interface port on top of the canopy; latches release the box door and the canopy port door simultaneously. A mechanical elevator lowers the two doors, with the cassette riding on top, into the canopy covered space. A manipulator picks up the cassette and places it onto the cassette port/elevator of the equipment. After processing, the reverse operation takes place.

The SMIF system has been proved effective by experiments using prototype SMIF components both inside and outside a clean room. The SMIF configuration achieved a ten-fold improvement over the conventional handling of open cassettes inside the clean room.

Modern processing equipment must be concerned with particle sizes which range from below .01 micrometers to above 200 micrometers. Particles with these sizes can be very

damaging in semiconductor processing. Typical semiconductor processes today employ geometries which are 1 micrometer and under. Unwanted contamination particles which have geometries measuring greater than 0.1 micrometer substantially interfere with 1 micrometer geometry semiconductor devices. The trend, of course, is to have smaller and smaller semiconductor processing geometries.

In typical processing environments today, "clean rooms" are established in which, through filtering and other techniques, attempts are made to remove particles having geometries of .03 micrometer and above. There is a need, however, to improve the processing environment. The conventional "clean room" cannot be maintained as particle free as desired. It is virtually impossible to maintain conventional clean rooms free of particles of a .01 micrometer size and below.

For this reason, systems such as the SMIF system have come under consideration. The proposed SMIF systems, however, have not been fully satisfactory. The SMIF systems which have been proposed have not permitted a full seal to be maintained between the interior of the box and the interior of the canopy during a cassette transfer. The mechanisms for latching and unlatching both the doors have not been convenient and adequate for making the cassette transfer. Accordingly, there is a need for improved mechanisms.

The proposed SMIF system, however, has some deficiencies. When SMIF boxes become contaminated, it is very difficult to remove small contaminant particles since the force of attraction of small particles to surfaces of equipment is very high. When small particles become attached to a surface such as a SMIF box, they are not effectively removed by filtration techniques. Circulating and filtering air or other gas within a box does not readily remove the contamination particles which are attracted and held in contact with surfaces.

Whenever an object such as a SMIF box is disturbed, by bumping for example, many small particles are freed from the surface and find their way as contaminants into any semiconductor or other article which is present in the box. Also, moving parts of a box system tend to create contamination particles whenever surfaces rub together. Therefore, it is desirable to avoid movement of articles such as wafers, within a gox and to otherwise avoid the rubbing of parts.

While scrubbing and washing techniques have been developed for removing small particles from equipment and surfaces, these processes tend to be cumbersome and furthermore are not entirely effective. Where possible, it is desirable to avoid generation of contamination particles rather than rely upon their removable.

While proposed SMIF systems have been effective for excluding many unwanted contaminants, they have not been fully effective and need to be improved.

SUMMARY OF THE INVENTION

The present invention is a transportable container, such as a box, for maintaining articles to be processed, such as semiconductor wafers, clean. The wafers or other articles to be processed are placed in a holder. A rigid base supports the holder within the container. A retainer is provided for retaining the articles in the holder. The rigid base and holder are retractable from the container into a clean environment whereby the articles can be processed without contamination. When the base is retracted, the retainer is automatically retracted from the articles so that the articles can be removed from the holder.

The retainer includes a tongue which is moved by and in the direction of movement of the box door. The tongue is supported by a parallelogram support which causes the

tongue, when moved by the box door, to also move orthogonal to the direction of box door movement. This orthogonal movement causes the tongue to hold the articles in place whenever the box door is closed and to release the articles whenever the box door is opened.

The rigid base functions as a box door which seals the articles into the box. The box including the disposable liner is used to transport the wafers to a port which is an opening in the canopy of the processing equipment. The port is adapted for receiving the box and box door and for transferring the box door and the contents of the box into a region beneath the canopy. The canopy makes a seal with the box. A port door is provided in the canopy opening for closing the port when no box is present. A box door latch is provided for latching the box door to the box whereby a seal is made and released between the box door and the box by operation of the box door latch. A box latch is provided for latching the box to the canopy whereby a seal is made or released between the box and the canopy by the operation of the box latch.

In one particular embodiment, the retainer is a fluoroplastic or other plastic.

In another embodiment of the invention, a box liner is provided with a tongue in one of the liner walls facing wafers in the cassette. The tongue in the liner is positioned between the retainer and the wafers or other articles. The tongue in the liner is actuated to the closed position by the tongue of the retainer. When closed, the tongues of the liner and of the retainer tend to hold the wafers in place. In order to remove the cassette and the wafers, box door is opened thereby retracting the retainer. The liner is formed with spring loops which cause the liner tongue to retract whenever the retainer tongue is retracted, thereby allowing the wafers and cassette to be withdrawn from the box and liner.

The present invention provides an improved container with a box door activated retainer for transporting articles to be processed.

Additional objects and features of the invention will appear from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the drawings.

BRIEF SUMMARY OF THE DRAWINGS

FIG. 1 depicts a perspective view of a SMIF system positioned adjacent processing equipment.

FIG. 2 depicts a schematic representation of the SMIF system and the processing equipment of FIG. 1.

FIG. 3 depicts an exploded perspective view of a port assembly of the FIG. 2 apparatus.

FIG. 4 depicts a cross-sectional front view of a box having a retainer and portions of the port assembly with the box door and retainer in the closed position.

FIG. 5 depicts a top view of the FIG. 4 apparatus.

FIG. 6 depicts a front view of FIGS. 4 and 5 apparatus with the box door and retainer in the open position.

FIG. 7 depicts a top view of another embodiment of a box with a disposable liner in which a spring-operating tongue is formed in one sidewall of the liner juxtaposed a retainer tongue.

DETAILED DESCRIPTION

In FIG. 1, the canopy 10 is an easily removable shield that

covers the wafer-handling mechanisms of the processing equipment 15. Equipment 15 is a photoresist applicator, mask aligner, inspection station, or any similar processing equipment. The canopy 10 is constructed of transparent plastic such as Lexan to facilitate inspection and/or maintenance within the canopy 10. The canopy 10 encloses the handling mechanisms of the processing equipment 15. The box 90is located to permit a holder in the form of wafer cassette, holding wafers 82 to be unloaded under the canopy 10 of the equipment 15.

FIG. 2 shows further details of the FIG. 1 apparatus. The box 90 is mounted and held by box latches 45 on an horizontal surface 40 of the canopy 10 by means of a canopy mounting plate 50. The port assembly 20 further includes a rigid base in the form of a box door 99, a port door 60 and an elevator mechanism 70 that transports a cassette 80, containing the integrated circuit wafers 82, from the box 90 into the region beneath the canopy 10. The box 90 includes a box liner 5 and a base liner 6. When the box and port doors are lowered, the box liner 5 remains within the box while the base liner 6 is lowered with the box door. In FIG. 2, the port door 60 and the box door 99 are shown in the closed positions by broken lines and are shown in the open position by solid lines. The mover assembly 29 includes a platform 26, a shaft engagement means 72, and a drive motor 28.

The platform 26, extending from the elevator assembly 70, carries the port door 60, the box door 99, the cassette 80 in a vertical direction. The platform 26 is attached by engagement means 72 to a vertical guide 71 of elevator assembly 70. Typically, guide 71 includes a lead screw (not shown) and motor 28 drives a gear (not shown) which engages the lead screw for driving the platform 26 up or down. When platform 26 is driven to the closed position, the port door 60 closes the port opening in the canopy 10.

In a similar manner, the manipulator assembly 30 is fastened to a platform 27 which has an engagement means 73 for engaging the vertical shaft assembly 71. Manipulator 30 includes a manipulator arm 31 and an engagement head 32 adapted to engage the cassette 30. By verticle operation of the platforms 26 and 27 and operation of the manipulator 30, the cassette 80 is moved from its position on the box door 99 to a position on the equipment station 13 (as shown by the broken lines).

In FIG. 3, an exploded, perspective view of the port assembly 20 is shown in further detail. The box 90 defines a first region 1 and a second region 2 where first and second seals are to be made with the port plate 50 and the port door 99, respectively. The box 90 includes an alignment tab 34 which is received by the alignment opening 44 in the guide rail 55 which forms part of the port plate 50.

In FIG. 3, the box door 99 has a vertical wall 99-1 and a horizontal wall 99-2. The vertical wall has the opening 97-1 and 96-1 which are aligned with the plugs 16-1 and 16-3, respectively. The wall 99-1 extends generally around the perimeter and is terminated at one end by the region 2 and at the other end by the region 3. Typically, the regions 2 and 3 can be machined so that the region 2 falls in one plane and the region 3 falls in another plane parallel to the plane of region 2. The wall 99-2 extends perpendicular to the wall 99-1 and is enclosed around its perimeter by the region 2. Within the wall 99-2, on the underside, are cone shaped receptors 57-1 and 57-2 which are alignment cones for receiving the cones 56-1 and 56-2 which protrude from the port door 60.

In FIG. 3, the port plate 50 and the guide rail 55 surround the port opening 58. Around the perimeter of the port opening is the region 1 on the surface 40 adjacent the guide rail 55. The region 1 in the port plate 50 is adapted to receive the region 1 of the box 90. Also the guide

rail 55 has a slotted opening 44 for receiving the tab 34 from the box 99.

In FIG. 3, the opening 58 is large enough such that the box door 99 will slide through the opening with a clearance distance. When assembled together, the region 3 which is the bottom end of the wall 99-1 extends to the opening 58 to mate with the region 3 around the raised portion of the port door 60. The region 4 of the port door 60 is designed to mate with the region 4 of the port plate 50 to form a fourth seal.

The port door 60 includes four actuator pins 17-1, 17-2, 18-1 and 18-2. These pins extend above the plane of the region 3 so as to extend above the surface 40 and align with the springs, such as the spring 19-2 attached to the vertical wall 99-1 of the box door 99.

The box 90 has a first region 1 which forms a first seal with a region 1 on the top surface of the mounting plate 50. The box 90 has a second region 2 which forms a second seal between the box 90 and the box door 99.

The box door 99 includes the second region 2 for forming a second seal with the box 90 and a third region 3 for forming a third seal with the port door 60. The port door 60 includes a fourth region which forms a fourth seal with a fourth region on the mounting plate 50. These four regions 1, 2, 3 and 4 extend around the entire circumference of the box and enclose the port opening 58. Accordingly, the box 90 and the canopy can be under vacuum or pressure.

The port door 99 has a vertical wall 98 having an opening 97-1. A spring extends through the opening 97-1 in wall 98 and engages a registration plug 16-1. When the spring 19-1 engages the plug 16-1, the box door 99 is held engaged with the box 90 so that a good seal is made in the region 2. As shown in FIG. 3, the spring 19-2 engages the plug 16-2.

The springs, like spring 19-2 are held engaged by spring operation. To disengage the springs a solenoid and actuating arms are translated. Vertical pins connecting through holes in the springs such as vertical pin 18-1 connecting through a hole in spring 19-2, operate to withdraw the springs from the plugs 16-1 and 16-2. When withdrawn, the box door 99 can be separated from the box 90.

In FIG. 4, further details of the port assembly 20 are shown with the cassette 80 fully inserted into the box 90.

The box door 99 and the port door 60 are both closed and the box 90 is latched in contact with the port plate 50. In this position, the port assembly of FIG. 4 has all of the seals 1, 2, 3 and 4 closed.

The port assembly of FIG. 4 includes a retainer 86 which functions to hold the wafers 82 within the cassette 80. The retainer 86 includes a retainer tongue 87 which is either in contact with or within a clearance distance of the edge of the wafers 82. In this closed position, tongue 87 prevents any of the wafers 82 from any substantial movement in the direction of arrow 94. The cassette 80 holds the cassettes 82 and prevents them from moving in any substantial amount in the direction of arrow 93.

The retainer 86 includes a box door member 88 which extends along the length of tongue 87 and is in contact with the box door 99 in the region of recess 92. Attached to the door member 88 is one parallelogram arm 76. Attached to the arm 76 are two side parallelogram arms 83 and 84. The side arm 83 and 84 attach to the box 90 at two display locations which form the parallelogram arm 77. The arms 76 and 77 are the same length as are the side arms 83 and 84. Arms 83 and 84 are pivotively connected to both the arms 76 and 77. Whenever the box door 99 is opened and moves in the direction of arrow 93, the member 88 is lowered also in the direction of arrow 93, by the operation of gravity,

causing the side arms 83 and 84 to pivot. The pivoting of the arms 83 and 84 causes the tongue 87 to travel not only in the direction of arrow 93, but also in the direction of arrow 94, thereby retracting the tongue 87 away from the wafers 82. The tongue 87 moves uniformly at the top of the wafers 82 and the bottom of the wafers 82 in the direction of the arrow 94.

In FIG. 5, a top view of the box of FIG. 4 is shown. The tongue 87 is wide enough to extend to either side of the flat edge 89 of the wafer 82. In FIG. 5, the wafer tongue 87 is shown in the closed position, represented in FIG. 4.

In FIG. 6, the box and port assembly of FIGS. 4 and 5 is shown with the box door 99 and the port door 60 moved downward in the direction of arrow 93 toward the open position. In FIG. 6, the tongue 87 has been translated in the direction of arrow 94 from its previous displacement D_1 to a shorter displacement D_2 as measured from a vertical line approximately at the inner surface of the vertical wall of box 90. The opening, as measured between the displacements in D_1 and D_2, enables the cassette 80 and the wafers 82 to be easily withdrawn in the direction of arrow 93 out of the box 90. In a similar manner, when wafer 82 and cassette 80 are to be returned back into the box 90, that is moved in a direction opposite to that of arrow 93, the retainer 86 remains open at D_2 position until the depression 92 in the box door 99 reaches the bottom position 78 of the box member 88. When the box door 99 and depression 92 reach the position 98, just prior to the time that the seals in the regions 2 and 4 are made, the tongue 87 begins to translate in the direction opposite to that of arrow 94 from the D_2 to the D_1 position. After that time, when the box door 99 has been fully inserted to make the seal and the region 2, the box 90 and the box door 99 can be unlatched from the port plate 50 and the retainer 86 remains with the tongue 87 in the closed position at D_1. Even though the box 90 may be jarred or bumped, the wafers 82 are restrained from

any substantial movement. This restraint tends to reduce the movement of contamination particles.

In FIG. 7, a top view of another embodiment of the present invention is shown. The box 90
Within the box 90 is a box liner 5 which although internal to the box 90, is external to the cassette 80 and the wafers 82. The box liner 5 sits upon a base liner 6 which is positioned beneath the cassette 80 on the box door 99. The box liner 5 and the base liner 6 are each made of a non-contaminating material such as a fluoroplastic. A fluoroplastic is a generic name for polytetrarfluoroethylene and its copolymers. One such well known fluoroplastic is marketed under the trademark Teflon. Such fluoroplastics are made by well-known techniques to be thin transparent films of approximately 0.0001 inch (0.0025 millimeter) or thinner or of relatively thick, more dimensionally stable, dimensions of, for example, 0.0025 inch (0.063 millimeter).

With any tichness fluoroplastic films are manufactured by processes which result in a relatively small number of contaminant particles where those particles are small (generally less than 0.1 micron). Furthermore, the contaminants which do exist are fluoroplastic contaminants which are non-reactive. In general, fluoroplastic contaminants are chemically inert in semiconductor processing although they can cause physical imperfections. In general, fluoroplastic contaminants of a given size are more tolerable then other types of contaminants which appear as a result of equipment and semiconductor materials.

The box liner 5 and the base liner 6 in FIG. 2 are disposable liners. When the box 90 is to be loaded, prior to processing, with the cassette 80 and new wafers 82, any old liner previously in the box is discarded and a new liner is inserted. Accordingly, any contaminants which may exist on the box 90, resulting from previous uses in different process locations, are shielded from the wafers 82 and the

cassette 80 by the liner 5 and the liner 6.

Because the liner 5 and the liner 6 are soft flexible fluoropastics, the operation of inserting and retracting the base 110 into and out of the box 90 of FIG. 2 permits the plastic liner to shrink or expand in volume. The change in volume minimizes the turbulence of any surrounding gas, such as air, resulting from insertion and retraction of wafers into and out of the box 90. The filtered air vent 91, when employed (see FIG. 7), allows any differential air pressure from inside to outside the box to be equalized. Any movement of air (or other gas) tends to be between the liner and the box. Therefore, the air surrounding the wafers and inside the box liner 5 tends to remain still.

In one embodiment, the liners 5 and 6 are an electret material which has the property of attracting and holding small charged particles. Such an electret is formed, for example, by the radiation of fluoroplastic such as liners 5 and 6, with an appropriate radiation (x-ray) source. Such radiation has the effect of separating positive and negative charges within the fluoroplastic thereby importing the electret property to the fluoroplastic.

In another embodiment, the liners 5 and 6 are formed of a conductive material. In one example, the fluoroplastic liner as previously described is formed within a thin conductive mesh so as to provide a static shield around the cassette 80 and the wafers 82. A conductive wire mesh having conductors formed of wires of approximately .001 inch (0.025 millimeter) diameter gold with approximately .005 inch (0.12 millimeter) spacing is satisfactory.

In another embodiment, the liner 5 includes on its inner surface an adhesive material which tends to hold particles which strike the liner 5.

The liners 5 and 6, when formed of thin fluoroplastic, tend to be transparent thereby facilitating optical observation of the wafers and cassettes. The fluoroplastic or other material can be made translucent or opaque.

In one particular embodiment, the liner is manufactured with a pigment for filtering out unwanted light. In general, the unwanted light is ultraviolet light utilized in photographic exposure of photographic emulsions spread on top of wafers during the wafer processing. Whenever the light-sensitive materials are placed on the wafers, the wafers must be shielded from unwanted exposure. In typical clean rooms, yellow fluorescent lights are employed. Also, red, dark-room lights may also be employed. These lights, however, make it somewhat difficult for operators within the wafer processing environment to have adequate lighting for carrying out other functions. When the box or liners of the present invention are formed as filters, the wafers become adequately protected without need for clean-room yellow or dark-room red to protect the wafers. Because the wafers are maintained within the box and liner and under the canopy, no unwanted ultraviolet or other radiation reaches the wafers.

In FIG. 2, the base liner 6 includes a vertical wall 7 which terminates inside the vertical wall of the box 99 and allows the liner 5 to fit outside the base liner wall 7. In this manner, the base liner 6 and the box liner 5 are in continuous contact so that the cassette 80 and the wafers 82 are totally enclosed by the liner formed by the box liner 5 and the base liner 6. Accordingly, if any contaminants happen to be located within the interior of the box 99, those contaminants are still isolated from the internal region occupied by the cassette 80 and the wafers 82.

In the embodiment of FIG. 7 the box liner 5, being a thin plastic material adheres to the inner surface of the box 99. As shown in FIG. 7 the box liner 5 does not contact

the wafers nor the wafer cassette 80 but rather, remains by surface adhesion in contact with the box 99. Accordingly, there is no rubbing of the cassette 80 or the wafers 82 against the liner 5 whenever the cassette is inserted into or withdraw from the box 99.

In FIG. 7, an embodiment is shown wherein the liner includes a mechanically-actuated retainer 86. The loops 8-1 and 8-2 in the liner 5 connect to a liner tongue 9 which rests against the wafers 82 so that the wafers 82 are retained in place within the cassette 80. Both the loops 8-1 and 8-2 and the liner tongue 9 are typically made from the same fluoroplastic material as the rest of liner 5. The loops 8-1 and 8-2 are made thicker than the rest of liner 5 to impart elastic, spring-like force to the tongue 9. Positioned on the outside of the liner 5 and between the loops 8-1 and 8-2, is the retainer 86 similar to the retainer 86 of FIG. 4 but without tongue 87. In place of tongue 87 is a retainer tongue 49 which engages the back of the liner tongue 9. The actuation of retainer 86 to the closed position forces the tongues 9 and 49 toward the wafers 82 thereby compressing the loops 8-1 and 8-2 and moving the retainer 9 in contact with or to within a clearance distance of the wafers 82. The retainer 9 is shown in the retracted position by the broken-line liner retainer 9'.

When the retainer 86 is actuated to the open position, the spring force of the loops 8-1 and 8-2 withdraws the retainer 9 to the open position 9'.

The use of both the canopy 10 and the box 90 as described above excludes human intrusion into the immediate environment of the wafers 82 and avoids the undesireable use of constantly moving filtered air. Cleanliness is achieved by maintaining a still-air interior environment rather than by a filtered moving-air environment. The canopy 10 and box 90 can each be equipped with particle-filtered openings 11 and 91 respectively, as in FIGS. 1 and 7, to allow continu-

ous equalization between internal and external (ambient) air pressures. Such filtered pressure equalization openings 11 and 91 act to minimize pressure differences and, consequently, air flow between the canopy 10 and box 90 as the wafers are moved from the box 90 into the canopy 10. In addition, since access to the interiors of the canopy 10 and box 90 are by means of mechanical arms which occupy essentially constant volume within the enclosures, no significant change in interior volume occurs as IC wafers are moved about.

In many of the embodiments described, the box liner is thin plastic which adheres to the internal surfaces of a mechanically rigid plastic box. However, the box liner itself may be constructed of a thicker plastic which is mechanically and dimensionally stable all by itself. In such an embodiment, the box liner covers the wafer holder and wafers whether or not a rigid external box is employed. In such a case, the retainer 86 is attached to a bracket which forms the arm 77 (see FIG. 4).

In one embodiment, the box liner is formed of a polystyrene and a fluoroplastic lamination. The fluoroplastic is the inside layer and the polystyrene is the outside layer where the polystyrene is added to give mechanical strength.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and detail may be made therein without departing from the spirit and scope of the invention.

CLAIMS

1. A transportable container for articles to be processed comprising,

a box having an opening for receiving a box door,

a holder for holding one or more articles to be processed,

a box door supporting the holder,

a base-actuated retainer adapted to extend along said holder to retain said one or more articles to be processed whenever said box door closes said opening,

said rigid base and holder being retractable from said disposable liner into a clean environment whereby said retainer is displayed from said articles.

2. The container of Claim 1 wherein said retainer included a tongue adapted to hold said articles, includes a first arm connected to said tongue includes a second arm, equal in length in to said first arm, connected to said box, includes a third arm connecting the ends of said first and second arms and including a fourth arm connecting the other end of said first and second arms, said first, second, third and fourth arms forming a parallelogram, said third and fourth arms pivotaly connected to said first and second arms whereby movement of said first arm in on direction causes translation of saids tongue in a second direction or thonigal to said first direction.

3. The container of Claim 2 wherein said retainer includes a box door number adapted to actuate said first in in said first direction by the operation of the opening and closing of said box door.

4. The container of Claim 1 further including a box liner insertable internally to said box through said base opening, said box liner conforming to the inside walls of said box, said box liner having a liner opening surrounding said base opening whereby said holder and one or more articles

is insertable through the box base opening and whereby said holder and one or more articles to be processed are inserted within said box liner.

5. The container of Claim 4 wherein said box liner is a flexible plastic material and said unit includes means to attach said liner to the inside wall of said box, said box liner having loops for spring-loading said box liner away from said articles.

6. An apparatus for maintaining semiconductor wafers to be processed clean comprising,

a holder for holding one or more wafers to be processed,

a box for containing said articles, said box having first and second regions for making first and second seals,

a box door having a second region for making said second seal and having a third region for making a third seal, said box door supporting said holder,

a disposable box liner adapted to surround said holder and said one or more articles to be processed,

port means adapted for receiving said box and box door and for transferring said box door said holder and said articles into a clean region, said port means having a first region for making said first seal and having a fourth region for making a fourth seal,

a port door having a second region for making said second seal and having a fourth region for making a said fourth seal,

box door latch means for latching said box door to said box whereby said second seal is made and released in the second region between said box and said box door by operation of said box door latch means, and

a box-door-actuated retainer for holding said wafers in said holder whenever said box door is latched to said box.

7. The apparatus of Claim 15 wherein said first and sec-

ond regions are displaced in space and wherein said box door latch means operates in the space between said first and second regions.

8. The apparatus of Claim 16 wherein said box and said box liner have a box opening defined by said second region and wherein said box door functions to close said opening by making said second seal in said second region, said box door having a first wall extending between said first and said third regions extending generally around the perimeter of said box opening and having a second wall connected to said first wall and supporting said second region, said first and second walls defining an internal space generally surrounded by said second region, said box door latch means further including retention means extending through said first wall into said box for holding said box door stationary with respect to said box thereby closing said box opening.

9. The apparatus of Claim 15 wherein said box door has a cross-section in the shape of a H, wherein said second region is defined as the top of the vertical sides of said H and wherein said third region is defined at the bottom of said vertical sides of said H whereby said first and second regions line in parallel planes.

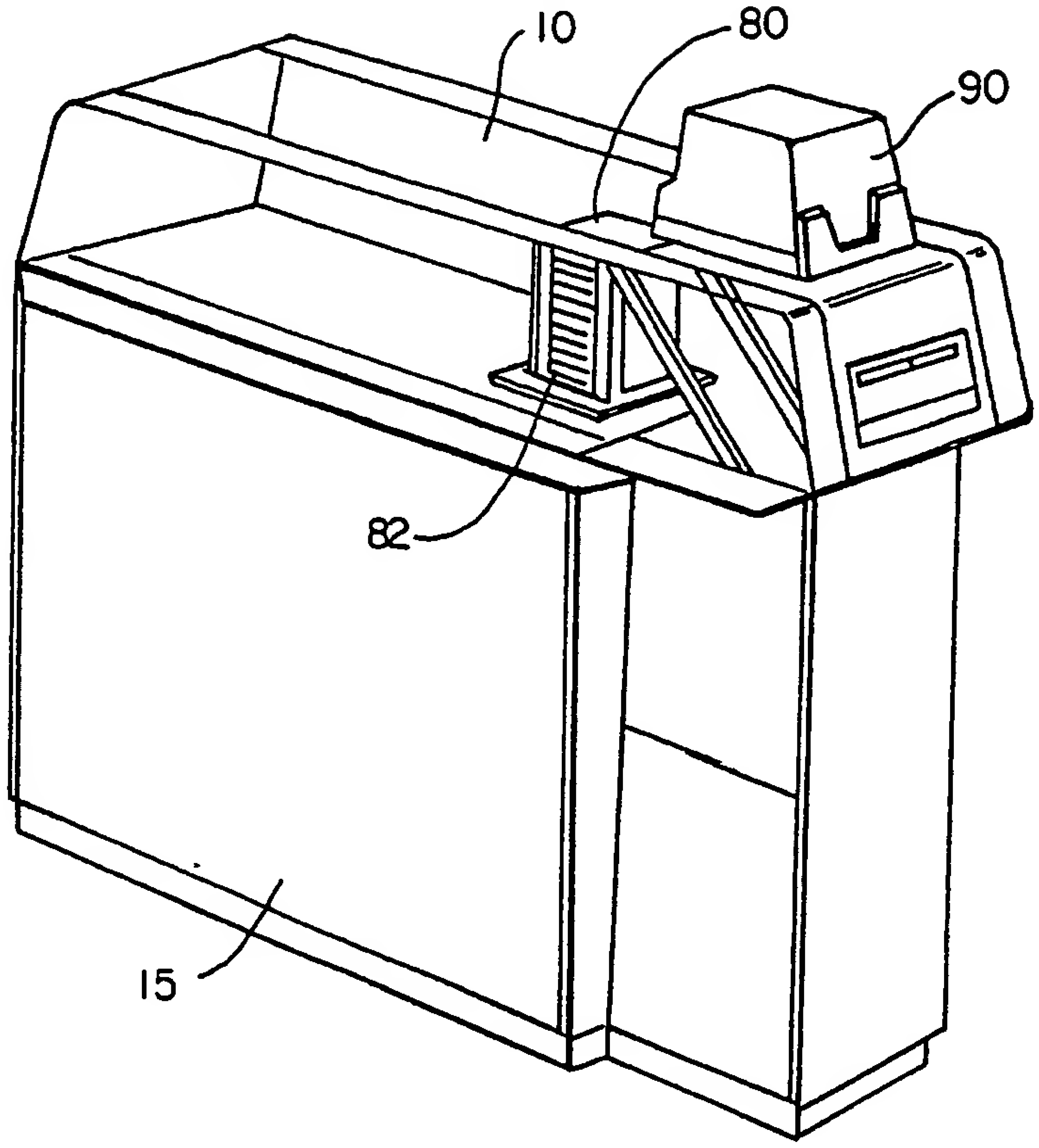

10
80
90
82
15

FIG.-1

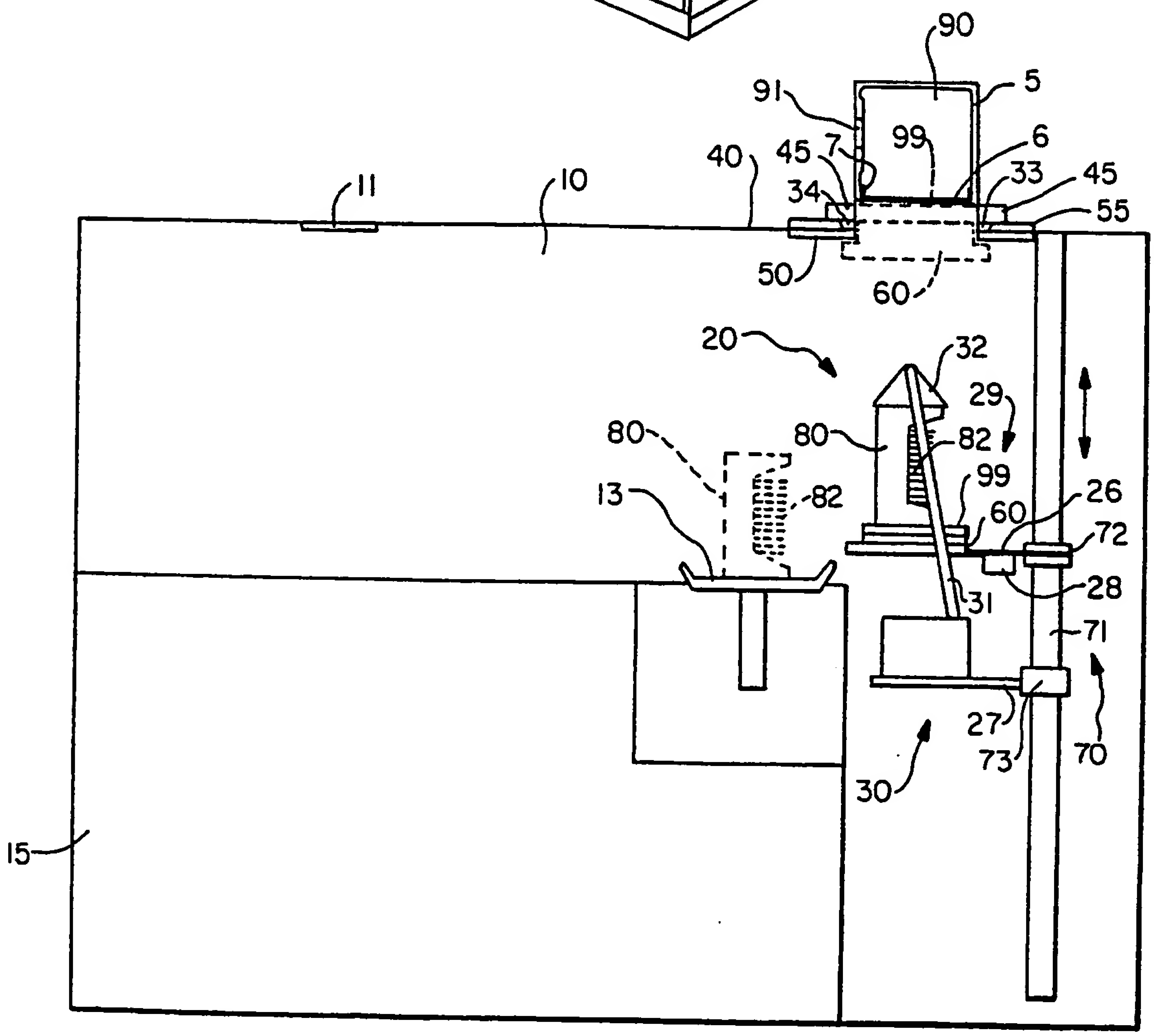

90
91
5
99
6
40
45
7
33
45
34
55
11
10
50
60
20
32
29
80
80
82
99
13
82
26
60
72
28
31
71
27
73
70
30
15

FIG. – 2

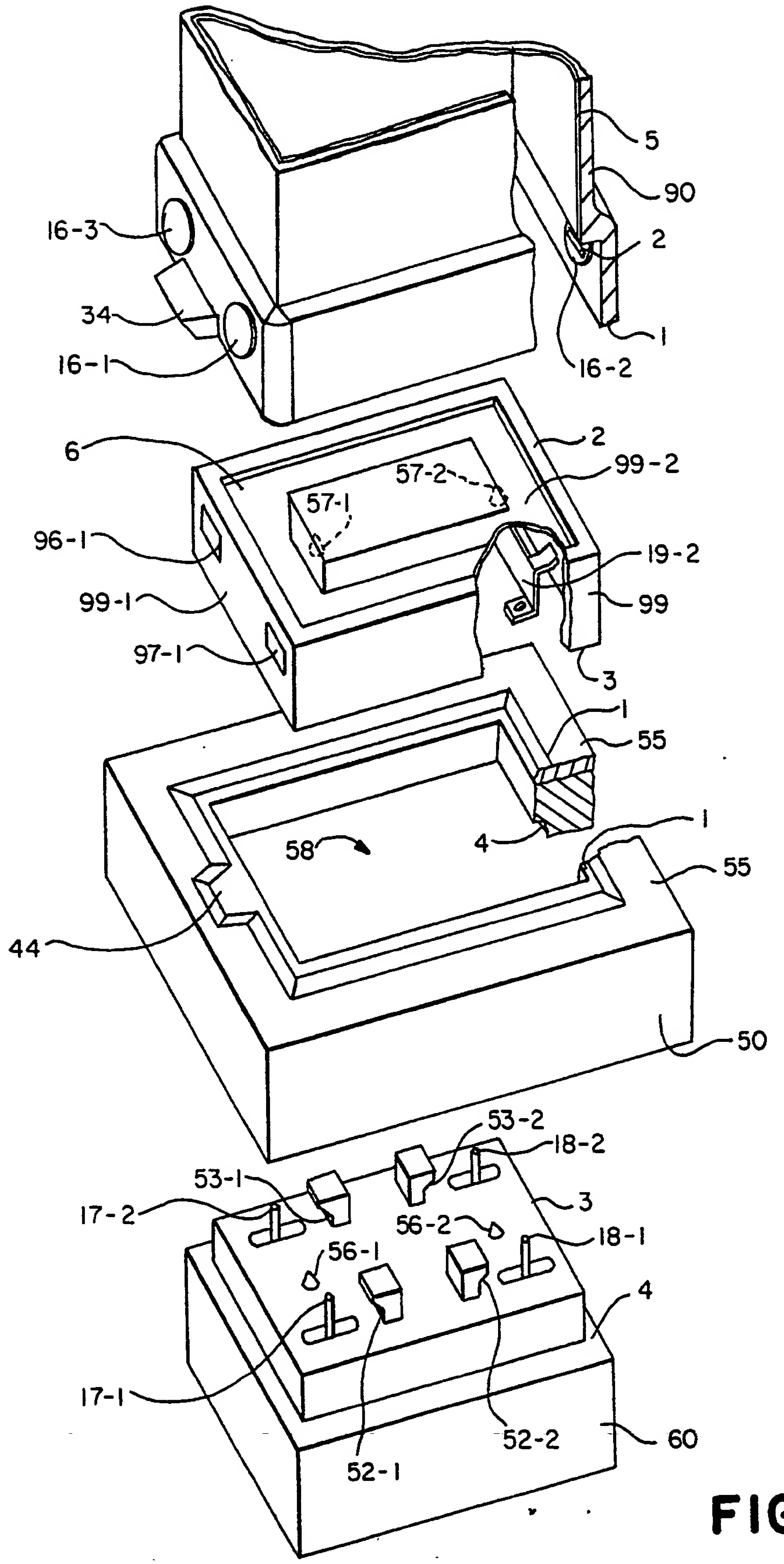

5
90
2
1
16-3
34
16-1
16-2
6
2
57-2
99-2
57-1
96-1
19-2
99-1
99
97-1
3
1
55
58
4
1
55
44
50
53-2
18-2
53-1
3
17-2
56-2
18-1
56-1
4
17-1
52-2
60
52-1

FIG. — 3

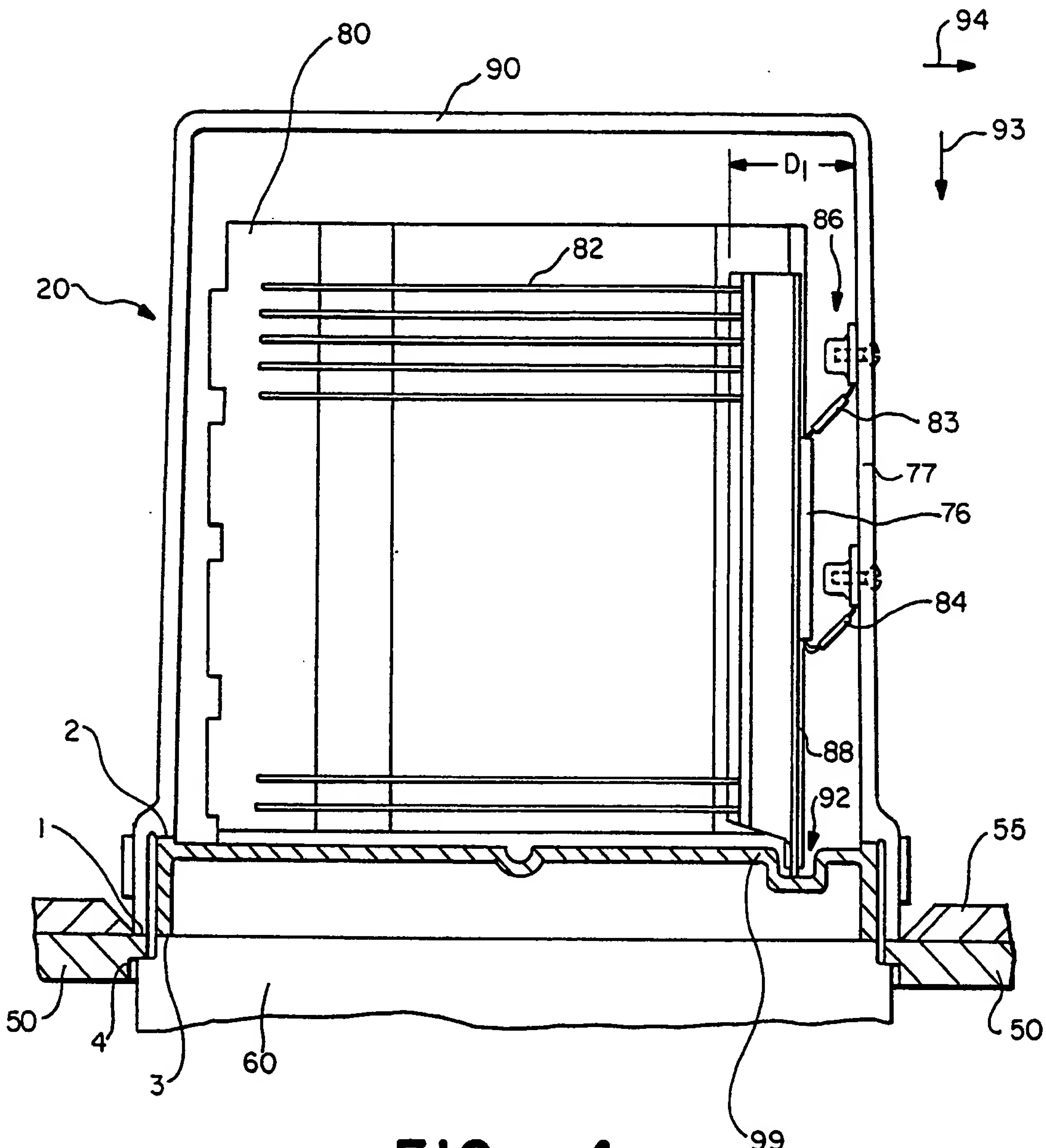


FIG. — 4

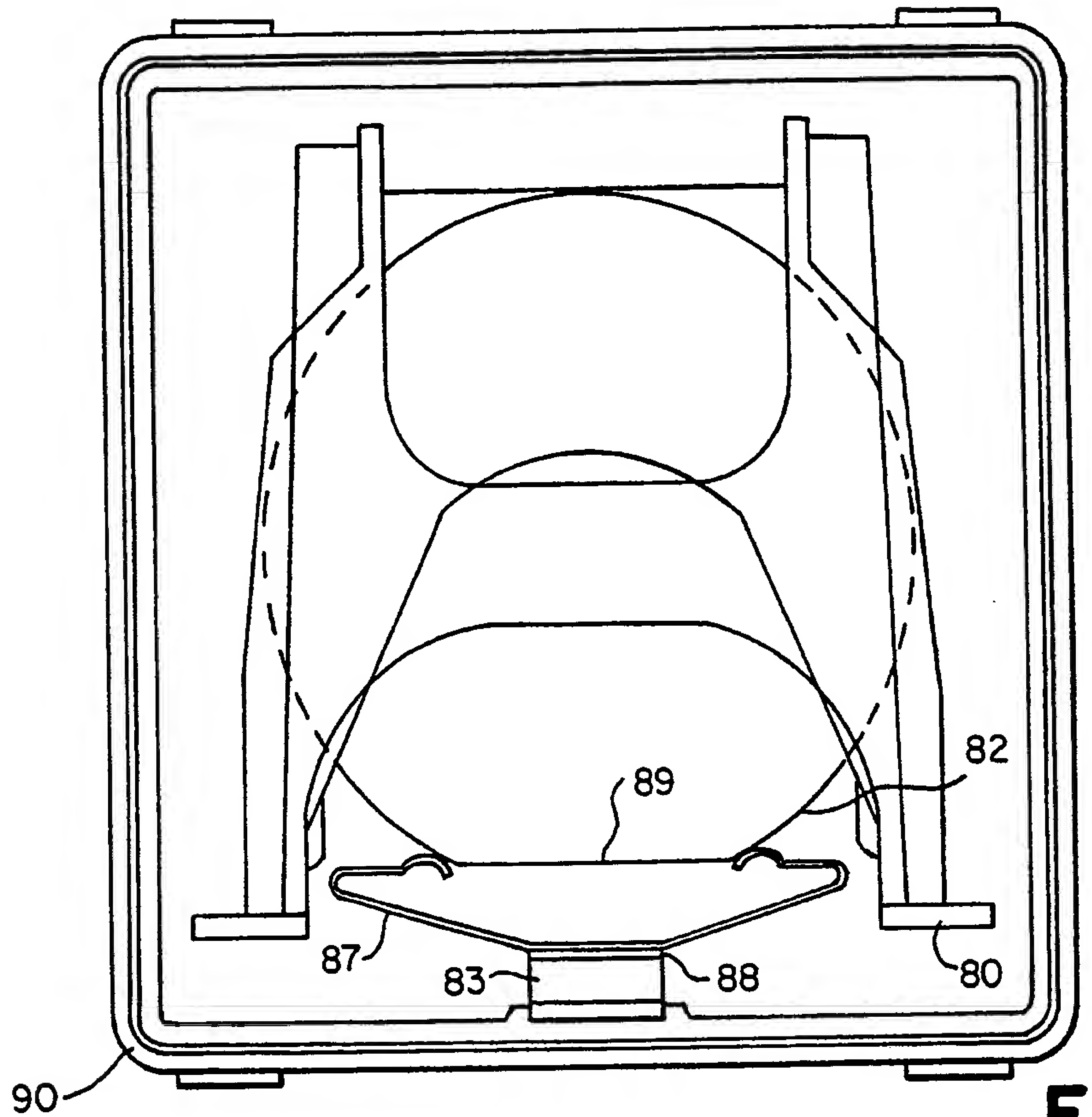


FIG.-5

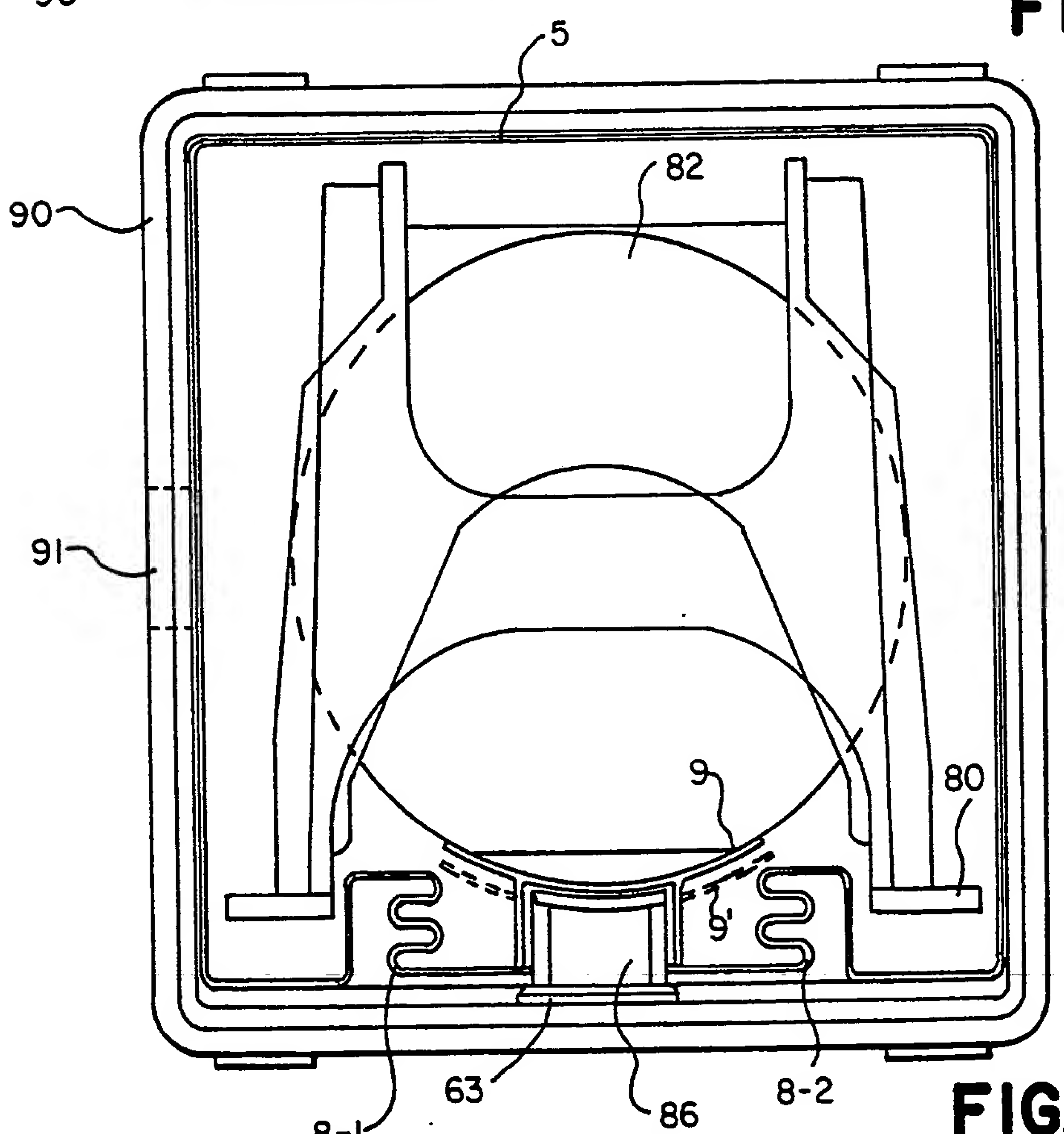


FIG.-7

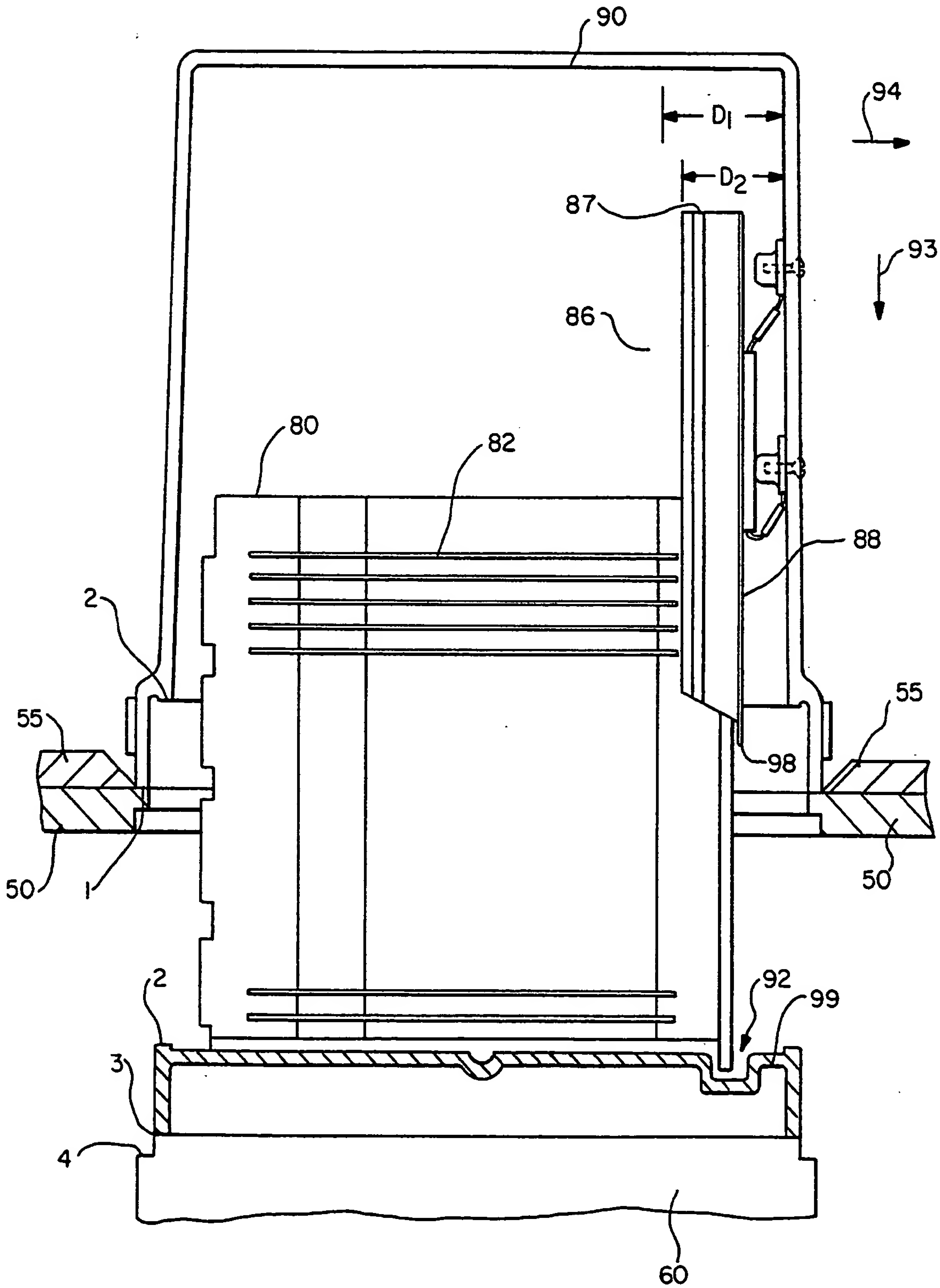


FIG. – 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 85/02575

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: H 05 K 13/02; H 05 K 13/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	H 05 K; C 30 B; C 23 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A, 0138473 (HEWLETT-PACKARD) 24 April 1985 see page 10, line 3 - page 12, line 22; figures 1,2 and 4 --	1
A	Solid State Technology, no. 7, July 1984 (Washington, US) M. Parkh et al.: "SMIF: a technology for wáfer cassette transfer in VLSI manufacturing", pages 111-115, see the pages 111-114 (cited in the application) ------	1

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8th September 1986	20 OCT 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 85/02575 (SA 11752)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 25/09/86

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0138473	24/04/85	JP-A- 60143623	29/07/85

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82